

UNIVERSITY OF MALTA
BOARD OF STUDIES FOR INFORMATION TECHNOLOGY
DEPT. OF COMMUNICATIONS & COMPUTER ENGINEERING
B.Sc. I.T. (Hons.) – Year IV
January 2000 Examination Session

CEA 401 – ADVANCED COMPUTER ARCHITECTURE

20 JANUARY, 2000

0900 – 1130

*This paper contains **five** questions. You are to attempt **four** questions*

1. (a) Mention at least FOUR parameters that need to be considered to ensure maximum possible speed-up when processors are to be made to execute a program in parallel ? (5 marks)
- (b) Four PC's are available for the computation of programs. These PC's are connected over a shared bus. Each PC has a local memory where the program to be executed and the part of the data to be used can be kept. The data is initially in one shared memory.
- The program can be divided into a serial section which comprises 0.3 of all the instructions, with the other 0.7 being able to run contemporaneously in parallel. The serial part is necessary to update the partial results to the shared memory, before the process is continued.
- (i) What is the ideal speedup of this configuration compared to using one PC only? (8 marks)
- (ii) In practice the parallel part has also as overhead a start-up time equivalent to 15% of the overall instruction time taken in the parallel operation.
What is the new speed-up in this case? (7 marks)
- (c) Mention at least one other non-ideality that further lessens the overall speed-up. (5 marks)

2. Traditionally static parallel architectures are considered for parallel computation. Static architectures are further differentiated using several parameters, including:

- (i) diameter
- (ii) number of links
- (iii) arc connectivity

(a) Define each of the above three terms.

(6 marks)

(b) Describe briefly, with diagrams, FIVE different parallel computer architectures, and for EACH type give, with reasons, the value of EACH of the three parameters mentioned in (a).

(13 marks)

(c) One of the most common applications of parallel computation is for flow analysis of the air pressure on an aircraft wing. Give, with reasons, a suitable parallel architecture for speed-up of such a computation. State clearly why this is your choice by comparing the inefficiencies of ONE other architecture of your choice with respect to this particular application.

(6 marks)

3. (a) One of the applications for a data pipeline is the addition of a set of numbers. **Figure 1** is a data pipeline with four stages and suitable buffers and multiplexers to allow input from an external source or from an internal buffer. 4000 numbers need to be added.

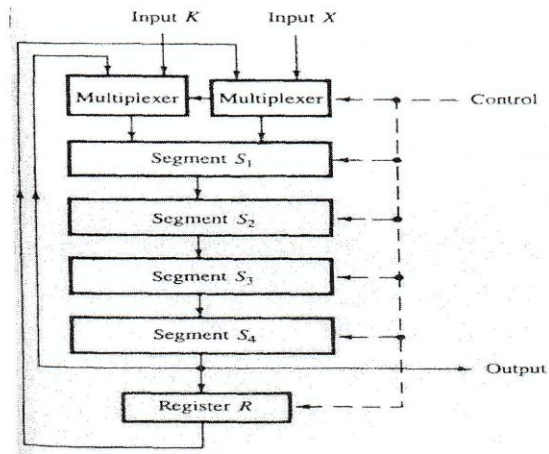


Figure 1

- (i) Give a brief description of how the addition can be organised. (8 marks)
- (ii) What is the speed-up obtained in this case? (5 marks)
- (iii) Describe how the system can be adapted for multiplication (5 marks)
- (b) What is a systolic array? Suggest two suitable applications that can be solved using a systolic array. (7 marks)

4. (a) **Figure 2** shows the use of a set of 2X2 switches to provide an interconnection among 8 processors. Each switch can have either a through connection from input to output, or a cross-connection from input to output.

A set of 2 X 2 switches are to be used to interconnect 12 processors.

- (i) Design an interconnect network that can connect any one of the 12 processors using these switches. (18 marks)

- (ii) Hence show the settings on the appropriate switches to connect processor 4 to processor 10. Assume the processors are numbered from 0 to 11. (7 marks)

(Hint: use 16 processors)

(7 marks)

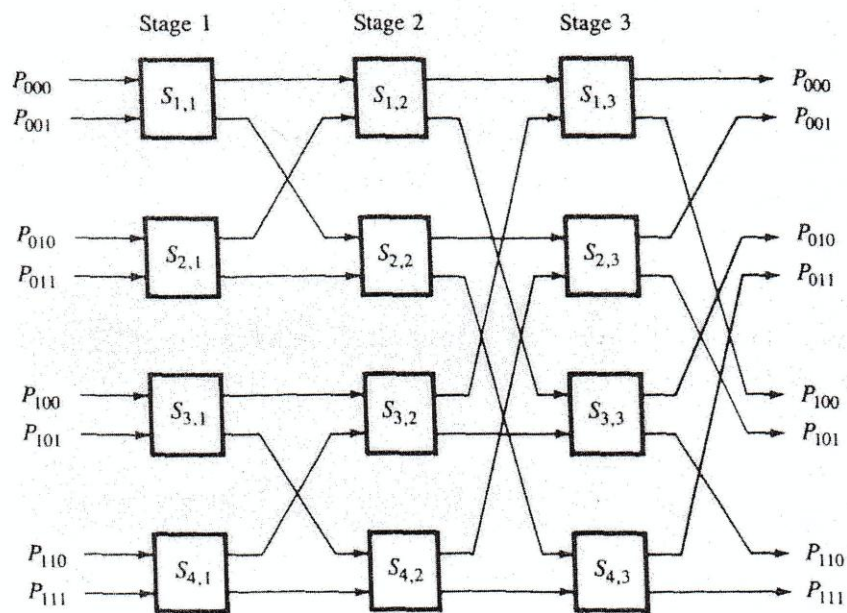


Figure 2